

What is claimed is:

1. A fuel cell device comprising:
  - a base portion, formed of a singular body, and having a major surface;
  - 5 at least one fuel cell membrane electrode assembly formed on the major surface of the base portion;
  - a water recovery and recirculating system positioned to recover reaction water from the at least one fuel cell membrane electrode assembly;
  - a fluid supply channel defined in the base portion and communicating with
  - 10 the at least one fuel cell membrane electrode assembly, the fluid supply channel including a mixing chamber and at least one fuel-bearing fluid inlet;
  - a water recovery and recirculation channel defined in the base portion and communicating with the at least one fuel cell membrane electrode assembly, the water recovery and recirculation channel in communication with the water
  - 15 recovery and recirculating system;
  - an exhaust separation chamber spaced apart from the fluid supply channel for exhausting gases from the at least one fuel cell membrane electrode assembly, in combination, the at least one fuel cell membrane electrode assembly, the water recovery and recirculating system, the cooperating fluid
  - 20 supply channel, the water recovery and recirculation channel and the cooperating exhaust separation chamber forming a single fuel cell system;
  - a plurality of electrical components formed in the base portion for electrical integration of the fuel cell assembly.

2. A fuel cell device as claimed in claim 1 wherein the base portion comprises a material selected from the group consisting of ceramic, plastic, glass, metal, and silicon.

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3. A fuel cell device as claimed in claim 2 further wherein the at least one fuel cell membrane electrode assembly formed on the major surface of the base portion includes a plurality of fuel cell membrane electrode assemblies formed on the major surface of the base portion wherein each of the plurality of fuel cell  
10 membrane electrode assemblies is spaced at least 0.01mm from an adjacent fuel cell membrane electrode assembly.

4. A fuel cell device as claimed in claim 1 wherein the fuel cell membrane electrode assembly further includes a first electrode, a film adjacent the first electrode, formed of a protonically conductive electrolyte, and a second electrode  
15 in contact with the film.

5. A fuel cell device as claimed in claim 4 wherein the fuel cell membrane electrode assembly further includes a gas diffusion layer positioned on the first electrode on a side opposite the adjacent film, and a gas diffusion layer positioned on the second electrode on a side opposite the adjacent film.  
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6. A fuel cell device as claimed in claim 5 wherein the water recovery and recirculating system includes an air supplier, characterized as generating a forced air stream across the fuel cell membrane electrode assembly.

5        7. A fuel cell device as claimed in claim 6 wherein the water recovery and recirculating system further includes an gas-liquid separator tank in fluidic communication with the forced air stream and the water recovery and recirculating channel and mixing chamber.

10      8. A fuel cell device as claimed in claim 7 wherein the water recovery and recirculating system further includes a reverse osmosis type membrane in fluidic communication with the air water separator tank and the water recover and recirculating channel.

15      9. A fuel cell device as claimed in claim 7 wherein the water recovery and recirculating system further includes a direct fluidic communication with the air water separator tank and the water recover and recirculating channel.

20      10. A fuel cell device as claimed in claim 7 wherein the water recovery and recirculation channel provides for the recovery and recirculation from the fuel cell back to the mixing chamber, of a remaining water and methanol mixture and reaction water collected from the water recovery and recirculating system.

¶1. A fuel cell device comprising:

a base portion, formed of a singular body, and having a major surface, the base portion formed of a material selected from the group consisting of ceramic, plastic, glass, metal, and silicon;

5 at least one fuel cell membrane electrode assembly formed on the major surface of the base portion, the at least one fuel cell membrane electrode assembly including a first electrode, a film formed of a protonically conductive electrolyte, and a second electrode;

a fluid supply channel defined in the base portion and communicating with

10 the at least one fuel cell membrane electrode assembly for supplying a fuel-bearing fluid to the at least one fuel cell membrane electrode assembly, the fluid supply channel further including at least one fluid inlet and a mixing chamber;

an exhaust separation chamber communicating with the at least one fuel cell membrane electrode assembly, the exhaust separation chamber spaced

15 apart from the fluid supply channel for exhausting gases from the at least one spaced apart fuel cell membrane electrode assembly;

a water recovery and recirculation channel in fluidic communication with the exhaust separation chamber, and mixing chamber;

20 a cap portion, including a water recovery and recirculating system, comprised of an air supplier, characterized as generating a forced air stream through a flow field, and across the at least one fuel cell membrane electrode assembly, and an gas-liquid separator in fluidic communication with the flow field and the water recovery and recirculation channel, in combination the base

portion, the at least one fuel cell membrane electrode assembly, the cooperating fluid supply channel, cooperating exhaust separation chamber, the water recovery and recirculation channel and the cap portion forming a single fuel cell assembly system.

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.12. A fuel cell device as claimed in claim 11 further including a plurality of spaced apart fuel cell membrane electrode assemblies formed on the major surface of the base portion, thereby forming a plurality of fuel cell assemblies.

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10 13. A fuel cell device as claimed in claim 12 wherein the plurality of fuel cell membrane electrode assemblies are electrically connected in one of a series electrical interface or a parallel electrical interface.

15 14. A fuel cell device as claimed in claim 11 wherein the first and second electrodes comprise a material selected from the group consisting of platinum, palladium, gold, nickel, tungsten carbide, molybdenum, ruthenium, and alloys or compounds of platinum, palladium, gold, nickel, tungsten carbide, molybdenum, ruthenium, or a catalyst material.

20 15. A fuel cell device as claimed in claim 11 wherein the at least one fuel cell membrane electrode assemblies each further include a gas diffusion layer positioned adjacent to the first and second electrodes.

16. A fuel cell device as claimed in claim 11 wherein the water recovery and recirculating system further includes a reverse osmosis type membrane in fluidic communication with the air water separator tank and the water recover and recirculating channel.

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17. A fuel cell device as claimed in claim 11 wherein the water recovery and recirculating system further includes a direct fluidic communication with the air water separator tank and the water recover and recirculating channel.

10 18. A fuel cell device as claimed in claim 11 wherein the water recovery and recirculation channel provides for the recovery and recirculation from the fuel cell back to the mixing chamber, of a remaining water and methanol mixture and reaction water collected from the water recovery and recirculating system.

15 19. A fuel cell device as claimed in claim 11 wherein the air supplier characterized as generating a forced air stream is one of a piezoelectric pump, a diaphragm pump, a peristolic pump, a rotary air pump, or an electric fan.

20 20. A method of fabricating a fuel cell device comprising the steps of:  
providing a base portion formed of a material selected from the group consisting of ceramic, plastic, glass, metal, and silicon;  
forming at least one fuel cell membrane electrode assembly on a major surface of the base portion, the at least one fuel cell membrane electrode

assembly including a first electrode, a film formed of a protonically conductive electrolyte, and a second electrode;

forming a fluid supply channel in the base portion for supplying a fuel-bearing fluid to the at least one fuel cell membrane electrode assembly, the fluid supply channel further including a mixing chamber and a methanol concentration sensor;

forming an exhaust separation chamber in the base portion, the exhaust separation chamber formed apart from the fluid supply channel for exhausting gases from the at least one spaced apart fuel cell membrane electrode assembly;

forming a water recovery and recirculating channel in fluidic communication with the exhaust separation chamber and mixing chamber

forming a cap portion including a water recovery and recirculation system for the recovery and recirculation of a remaining fuel-bearing fluid and a reaction water, the water recovery and recirculation system in fluidic communication with the water recovery and recirculating channel and the exhaust separation chamber;

forming the at least one fuel cell membrane electrode assembly on the major surface of the base portion, the step of forming the at least one spaced apart fuel cell membrane electrode assembly including the steps of providing for a first electrode on a major surface of the base portion, providing for a film formed of a protonically conductive electrolyte in contact with the first electrode, providing for a second electrode in contact with the film, the at least one spaced

apart fuel cell membrane electrode assembly and the cooperating fluid supply channel, cooperating exhaust separation channel and water recovery and recirculation system forming a single fuel cell assembly system, the cap portion further including a plurality of electrical components for electrical integration of  
5 the formed fuel cell assembly.

21. A method of fabricating a fuel cell device as claimed in claim 20 wherein the step of forming the water recovery and recirculating system includes forming an air supplier characterized as generating a forced air stream across

10 the at least one fuel cell membrane electrode assembly.

22. A method of fabricating a fuel cell device as claimed in claim 21 wherein the step of forming the water recovery and recirculating system further includes forming an gas-liquid separator in fluidic communication with the forced  
15 air stream and the water recovery and recirculating channel, and mixing chamber.